Human well-being, ecosystem services and watershed management in the Credit River Valley: Web-distributed mechanisms and indicators for communication and awareness

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Abstract

This paper seeks to assess 12 human health and well-being indicators through qualitative analysis. These 12 indicators are: air quality, traffic patterns/modes of transportation, land cover change, urban heat islands, % imperviousness, % canopy cover, water quality index, % people using natural space, proximity to green space, connectivity of green space, access to green spaces, and wildlife (habitat). To evaluate the utility of each indicator, 18 professionals from various organizations were interviewed. The interviewees were asked to score how relevant each indicator was to achieving their mandate, and the specific benefits of measuring each indicator for the well being of the general population and for vulnerable groups such as infants and seniors, as well as any weaknesses of the indicator, and who might be able to use the data in the future. This was a mixed-methods approach, and was based on the principles of grounded theory. Semi-structured interviews were conducted, and followed by a qualitative content analysis using NVivo software to group and code references to human health and well-being within all 12 indicators. Some quantitative analysis was also added to provide direction and reasoning to relevancy of the 12 indicators in terms of human health and well-being. The analysis included two data sets of 18, and 19 interviews, for a total pool of 37 interviews. Most of the indicators were ranked quite high, indicating relevance to human health and well-being over a number of various organizations. Most interviewees agreed that air quality and green spares have been found to have many benefits to human health and well-being. It was noted that indicators were hard to define and had a lot of overlap. Similar trends were found in the new data when compared to the previous researcher's

data set, and that the larger pool can perhaps add validity to the conclusions drawn from the data.

Foreword

This major paper was written to fulfill some of the learning objectives of my Plan of Study (POS). My area of concentration aimed to explore how and why ecosystem services such as watersheds are integral to maintaining a healthy environment and human well-being. My two components, or learning objectives, of the POS were Social and Environmental Determinants of Health, and Ecohealth and Watershed Management. The work of the major paper primarily addresses the second component, but the courses I have taken and work completed for fulfillment of the first component also shaped the major paper.

The first learning objective, Social and Environmental Determinants of Health, was structured so that I could gain an understanding of impacts of climate change on human health; how climate change can influence social and environmental factors of health; how complex ecosystems react to changing circumstances in the environment; and how climate change impacts the physical environment and the resulting management strategies that can emerge, as well as the role of ecosystem services. For this component I focused on taking applicable courses that would help me to not only understand the topics, but also be able to find the connections between them. The research in these courses led to developing a more informed educational background in topics of climate change, application of management strategies in environmental strategies, and the inherent complexities within ecosystems. The courses I took also helped me to develop applicable skills for data collection, analysis and dissemination.

The second learning objective, Ecohealth and Watershed Management, was structured towards the goal of the major paper. Within this objective, the learning strategies were to gain an understanding of Canadian policies related to public health, environmental/climate change, and environmental health; to gain the opinions of professionals about varying management strategies and their relevance to ecosystem services and human health; to improve understanding of the interconnectivity between human health and watershed management; and to gain a broad knowledge about the applicability of the ecohealth approach in different circumstances. These strategies focused on conducting the interviews with professionals in different fields to gain their opinion on selected indicators that relate to the environment and human health. It also enabled me to conduct in-depth research about the ecohealth approach, and to better understand it's potential for applicability in interdisciplinary projects.

The major paper hopefully provides a more in-depth analysis of the opinions of a number of individuals in the environment, but also policy and health fields, which can be helpful in creating conversations surrounding the general topic of conservation and watershed management. The benefit of this is to see how different disciplines view the same indicators, and their input towards dealing with complex systems.

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1. Introduction

1.1 Background

This research project is part of a larger project titled, "Human well-being, ecosystem services and watershed management in the Credit River Valley: Web-distributed mechanisms and indicators for communication and awareness". This project is a joint effort between York University, Faculty of Environmental Studies, and the Credit Valley Conservation.

1.2 Overview

A general introduction to this project is that it was formed in conjunction with the Credit Valley Conservation authority, and developed after conducting a workshop in which internal and external groups of experts convened to discuss and develop a list of well-being indicators that relate to watershed management and governance. Twelve indicators were developed: air quality, traffic patterns/modes of transportation, land cover change, urban heat islands, % imperviousness, % canopy cover, water quality index, % people using natural space, proximity to green space, connectivity of green space, access to green spaces, and wildlife (habitat). These twelve indicators were assessed using different categories including, but not limited to, it's value as an ecosystem service, well-being benefit of improving the indicator and potential uses for the indicator by managers/governance stakeholders.

1.3 Objectives and Organization

This research project builds on a previous project started by Iftekhar Ahmed, MES

Student, supervised by Martin Bunch. His objective was to "examine the role of watershed planning and governance in human health and well-being in the Credit River valley in southern Ontario". My primary objective was to continue to collect data and expand the data set to be able to further explorations of relationships between the Credit River watershed, human health and well-being, and the environment. The specific research question that I aimed to answer was: to identify and assess human health and well-being indicators, with reference to the Credit River watershed and the larger project.

This major paper is organized in six sections, with the first section being the Introduction, which includes the background, overview, objectives and organization and the context. The second section is the literature review that covers a number of relevant topics. The third section is the methods that were used throughout this project. The fourth section is the results and analysis, which presents the findings of the data collection. The fifth section is the discussion of the results, as well as some limitations of the project. The sixth and final chapter presents the conclusions.

1.3 Credit Valley Conservation Authority

The Credit Valley Conservation (CVC) authority is one of 36 conservation authorities within Ontario, and is dedicated to management of the Credit River watershed, as well as conservation and restoration efforts (Credit Valley Conservation (CVC), 2009). The CVC works in conjunction with stakeholders that include: municipalities and community members, businesses, other not-for-profit groups, environmental groups, as well as students. The CVC is the primary scientific authority for the Credit River watershed, and as such, they are committed to creating, developing and providing programs that support conservation, education, water resources and land management (CVC, 2009). The CVC's

vision is: “a thriving environment that protects, connects and sustains us”, and their mission is: “together, it’s our nature to conserve and our future to shape through the power of science, policy and leadership” (CVC, 2014). A few of the CVC’s goals include: planning for an environmentally sustainable future, developing scientific knowledge and innovative approaches that can be shared to enhance decision-making, and connecting communities with nature (CVC, 2014). The strategic plan for the CVC from 2015-2018 states that through the plan the CVC will: “conserve our natural and built heritage; develop the knowledge and tools needed to sustain our water resources; prepare for climate change and foster a diverse and resilient environment; engage residents, partners and stakeholders in a collective effort to protect, restore an enhance our local environment” (CVC, 2014).

As the CVC operates on a watershed wide basis, much of their work is dedicated towards watershed monitoring, and includes programs like the Terrestrial Monitoring Program. This program assesses the integrity of terrestrial forest, wetland and riparian ecosystems using ecological indicators to assess trends. They also produce assessment reports and have real-time stream flow monitoring system that can warn against potential flooding (CVC, 2009).

1.4 Context: Credit River Watershed and Demographics

The Credit Valley Conservation report title, “Rising to the Challenge: A Handbook for Understanding and Protecting the Credit River Watershed”, published in 2009, provides details about the Credit River Watershed, value of the watershed, demographics of the area, and the role of the Credit Valley Conservation authority. A brief summary of the report will follow to provide some contextual details about the watershed, as well as the

Credit Valley Conservation authority. Additionally, some details from the CVC report titled, "Socio-Demographic Profile: The Credit River Watershed 2008-2018", published in 2014, will be included.

The Credit River originates in Orangeville, runs through the Niagara Escarpment, and drains into Lake Ontario in Mississauga. The watershed itself is approximately 860 square kilometers, which includes the 90-kilometer long Credit River, as well as 14 smaller creeks and streams that are smaller watersheds, making the combined area of nearly 1 000 kilometers. The watershed is of great value in terms of ecosystem diversity, as it includes the Niagara Escarpment, Oak Ridges Moraine, the Lake Ontario shoreline, as well as many other conservation areas, all of which have many distinctive landscape features and are sources of freshwater. It can be divided into 22 sub-watersheds, which service different cities and regions (CVC, 2014).

The watershed has three zones: upper, middle, and lower. The upper watershed remains in a mostly forested state, with primary land use being agriculture and hobby farms and some settlement areas. The middle zone includes the Oak Ridges Moraine and the Niagara Escarpment, and therefore contains a large area of protected forests and green spaces. The water quality in the upper and middle zones remains in a good state, with minimal alteration to tributaries. Both, upper and middle zones remain in mostly natural condition, with minimal urban development and decreasing cultivation. The lower zone of the watershed is densely populated and urbanized, and includes the city of Mississauga, and parts of Brampton, and Oakville. The water quality in the lower zone is much poorer than that of the upper and middle zones. In 2013, the population in the entire

watershed was 901 148, with 90% of the population living in the lower watershed zone. The population in the lower zone is expected to grow by 70 000 residents by the year 2018 (CVC, 2009; CVC, 2014).

2. Literature Review

This section includes an extensive literature review relating to topics of human health and well-being, including the Ecohealth approach, grounded theory, the Millennium Ecosystem Assessment (MA), ecosystem services, watersheds, and indicators.

2.1 Environmental Health

Introduction of synthetic compounds into the environment has altered the physical composition of both the ecosystems into which compounds have been released, and also in humans (WHO, 2015). Human lifestyles and actions in society have influenced changes in the environment, and the environment also influences changes in society and lifestyles. For example, increased production of greenhouse gases (GHGs) is one factor of global warming, leading to climate change, leading to varying impacts on different scales based on region, resilience and overall health. Factors that are external to humans including biological, chemical and physical factors, which impact the behaviour of the environment, are the target of environmental health management strategies (WHO, 2015). "Good" environmental health includes preventing disease and spread of disease vectors, managing climate change impacts, and creating health-promoting environments (WHO, 2015).

2.2 Ecohealth

The ecohealth approach is an interdisciplinary approach that uses the principles of systems thinking, by recognizing that the environment is inextricably linked to humans through many realms of connectivity (Charron, 2012; Parkes, 2011). Ecohealth approaches focus on sustainability-based approaches that can penetrate the biophysical, social and economic realms that link humans and the environment. It is a unique

approach that is very interdisciplinary, which helps it cross and connect different dimensions of a complex system (Charron, 2012; Wilcox et al., 2004; Wilcox and Kueffer, 2008). Ecohealth research seeks to conduct research that can improve the understanding of changes in global ecosystems on human health, although most ecohealth work is directed at a local or regional scale (Wilcox et al., 2004). The approach is a way to shift the focus from short-term interventions to focus on long-term approaches that can cover multiple disciplines and integrate different types of knowledge to a complex problem. This way, future generations are able to benefit from the intervention. Ecohealth research is defined as an approach that: "formally connects ideas of environmental and social determinants of health with those of ecology and systems thinking in an action-research framework applied mostly within a context of social and economic development" (Charron, 2012). It also provides an arena in which new ideas can be vetted for, and new modes of knowledge transition can be formed (Wilcox et al., 2004).

2.2.1 Six Principles of Ecohealth

As it is an interdisciplinary field, there is no one standard approach, and many ideas have been successful when played out. The approach is built on six principles: systems thinking, transdisciplinary research, participation, sustainability, gender and social equality and knowledge-to-action. Each principle is valuable to the approach in different ways, and they partly outline the method to finding solutions for certain ecological or ecosystem related issues, but each principle also contributes to the collaborative approach that ecohealth champions (Charron, 2012).

The first principle, systems thinking, is valuable to the approach as it encourages thinking about the parts of any system in reference to their relationships with other system parts,

instead of just as a linear relationship from one part to the next (Charron, 2012). A systems thinking approach allows for a strategy to be both broad and logical (Eisenberg, Desai, Levy et al., 2007). The use of a framework that uses systems thinking, is that is can be catered to a specific issue, such as public health in relation to environmentally influenced disease and well-being risks. This principle leads into the next principle of transdisciplinary research.

The second principle is transdisciplinarity, specifically in research and strategy, where methods, theories and concepts are integrated from an academic perspective into a non-academic perspective, which helps to solidify the linking of system components, and mobilizes knowledge of non-academic partners. Thus, transdisciplinary research reinforces the cyclical approach of systems thinking (Charron, 2012). An example of this is merging the ecohealth and One Health approaches at a common point, so that maximum benefit can be achieved from the respective strengths of each approach (Zinsstag, 2012). Adding a structural platform to where two strategies can meet and organize can improve efficiency, and helps to cross traditional academic borders, and create a transdisciplinary approach that has an additional value of creating a dense knowledge and information base that can be used to address transdisciplinary issues such as sustainability, socioeconomic and socio-cultural aspects of health and improved capacity (Zinsstag, 2012).

The third principle is participation, which promotes the need for local innovation and cooperation. This not only reinforces the first two principles, but also improves relations between the local community by including their feedback and needs into the overall approach (Charron, 2012). The ecohealth approach can unite the human systems needed

for resource management on all scales, and when the community or local stakeholders are involved, the outcome is usually more positive (Bopp and Bopp, 2004; Jacobs et al., 2010). By creating links between the research or management team and local community members or stakeholders, it builds a sense of trust and inclusion, and also improves the knowledge base so that they are equipped to maintain the project or intervention even after the initial period (Bopp and Bopp, 2004; Jacobs et al., 2010). Participation also leads to improved transparency, increased capacity and for multiple interests and knowledge to be presented at a platform (Bopp and Bopp, 2004; Jacobs et al., 2010).

The fourth principle is sustainability, where the approach is built by integrating ecological and socially sustainable methods into it. This principle also highlights the importance of ethical and positive changes in the approach, but also in the local community where the proposed approach is targeted. It also refers to both the ecological sustainability of a project, as well as the social or economical sustainability. This requires flexibility, and room for changes to deal with unexpected situations (e.g., climate/weather, economic situation, participation) (Charron, 2012). The ecohealth approach combines the first three principles to deal with issues of sustainability, which can include dealing with aspects of high costs and lack of available technology used in a specific project (Bopp and Bopp, 2004). It can also address how a plan will be ecologically sustainable by planning for reduced waste, increased use of local resources, and a long-term plan of trying to ensure minimal environmental interference or damage. By including sustainability into the project plan, the strategy is able to mitigate or remove the setback that can occur when the intervening group or research team withdraws and the local community cannot maintain the intervention or project. This principle also

ensures that the strategy is ecologically sustainable, and can use community capacity and experiences in the plan.

The fifth principle is gender and social equality, which stresses the importance of considering the differences between genders in terms of physical health, and also in terms of social, economic, class and age groups (Charron, 2012). Different exposures can lead to different health outcomes (e.g., targeting of different hormone receptors disrupts hormone function, which has different outcomes in each gender). In a similar manner, but a different scale, effects of climate change including warming, El Nino effects, and ice melt is felt disproportionately in different areas of the world (Patz, Gibbs, Foley et al., 2007). This is a health and equity issue as there is an imbalance between the responsibility for carbon emissions and which populations are facing the impacts (e.g., Inuit populations in the Arctic facing warming, El Nino effects felt strongly in South America, Africa and Southeast Asia) (Patz, Gibbs, Foley et al., 2007; Harper, Edge, Wilcox et al., 2012).

The sixth, and last, principle is knowledge-to-action, which endorses equity and sustainability in every approach, and aims to ensure real-world action. This brings the principles full-cycle, and demonstrates their integrated nature and how they build the ecohealth approach collaboratively (Charron, 2012). Knowledge to action models that include components of the previous five principles have been evaluated to be the more successful models in terms of health equity and usefulness (Davison, Nudumbe-Eyoh and Clement, 2015). The ecohealth approach is a comprehensive strategy that considers the multiple stages of a project, and incorporates six principles into strategy to ensure an

approach that is flexible enough to adapt to different problems, but has enough rigour to strategically target different issues as they arise.

2.2.2 Challenges and Advantages of Ecohealth

The ecohealth approach has only gained momentum and support in the last two decades, and it is still comparatively new, relative to other recognized strategies. Ecohealth approaches are potentially useful for creating policies to deal with environmental issues that impact human health, as the approach can deal with many parts of the complex system better than conventional strategies, including creating applied solutions that are most applicable to a specific problem (Charron, 2012). Public health units are multi-sectoral, multidisciplinary and complex. The ecohealth approach is able to provide strategies for many public health problems including infectious disease re-emergence, dealing with extreme weather events (such as heat waves), and ensuring appropriate and accurate information is delivered to the public (Davison, Nudumbe-Eyoh and Clement, 2015; Nguyen-Viet, Doria, Tung et al., 2015; Sheffield, Durante, Rabona and Zarcadoolas 2014).

A challenge for the ecohealth approach in public health is integrating ecohealth and the One Health strategy, so that they can function together instead of as separate strategies. The One Health approach has several aspects, including monitoring and surveillance systems (Uchtmann, Hermann, and Hahn, 2015) that can potentially be integrated into the principles of the ecohealth approach. In this way, the ecohealth approach can then be used to guide and structure public health policies. Zinsstag discusses a potential converging point for these strategies, where the two can combine over the mutual interest in the research of ecosystems and human heath and well-being (2012). A field of interest

for both strategies is zoonosis and parasitic movement and control, and influenza epidemics and public health measures (Zinsstag, 2012). The convergence over a shared interest adds the structure needed to bring the two approaches together, which can then improve the efficiency and value of data collected. Furthermore, public health professionals are aware of and can benefit from both strategies separately, but a combined framework could allow for a more holistic approach that can be integrated into different public health needs (Leung, Middleton and Morrison, 2012). Increased partnership building and governance to implement a combined version of the two approaches can be useful in the future, no matter how knowledgeable the public health professional is about environmental health and human health (Leung, Middleton and Morrison, 2012).

2.2.3 Ecohealth and Water

Water quality and management is deeply related to human health and well-being, as humans rely on drinking water for survival. Therefore, sustainability of watersheds is of increasing importance, as they are the primary drinking water source in urbanized and rural areas alike. Watersheds are also shared by industry and agriculture, and are an important resource to manage. In the changing climate, water-borne diseases are of increased risk, including re-emergence of disease in areas where it was previously eradicated (Colwell and Wilcox, 2010). Water resource management can use the ecohealth approach to use ecologically focused thinking to create a transdisciplinary, equitable solution to the global health issue of water-borne diseases.

The ecohealth approach can also guide how water resources are managed by municipalities, by increasing stakeholder and community participation to create a more equitable and sustainable management strategy. When studying four water basins around the world, Jacobs et al. (2010) found that water-resource management and development needs to be linked to practices that are based on knowledge (local or otherwise) and research to improve efficiency, so that it can also address of social, economic and sustainability issues. Although establishing a relationship with stakeholder groups can be contentious at times, increased participation can lead to increased capacity and management skills, which are useful when considering water-resource management. Additionally, wetland ecosystem management and assessment can be used to develop ecohealth strategies that can inform planning, development and investment around the wetland ecosystem (Horowitz and Finalyson, 2011).

2.3 Millennium Ecosystem Assessment

The Millennium Ecosystem Assessment (MA) was a multi-million dollar United Nations project started by the Secretary-General, Kofi Annan, in 2000 (MA, 2005). The work started in 2001, with four reports published in 2005 to assess the major impacts of human interactions on the environment (MA, 2005; (Yang, Dietz, Liu and Luo, 2013). It was designed to be able to inform decision-makers with scientific details regarding how human health can be impacted by ecosystem changes (Carpenter et al., 2009). The MA states that "a dynamic interaction exists between people and ecosystems", and uses this principle to define the links between human well-being and their surrounding ecosystems (Millennium Ecosystem Assessment (MA), 2005). Four categories if ecosystems services were defined by the MA that include: supporting, provisioning, regulating and cultural services; and five dimensions of human health and well-being are related to each of the

four ecosystem services, which include: security, basic material for a good life, good social relations, and freedom of choice and actions (MA, 2005).

The MA has a diagram that illustrates the linkages between the ecosystem services and the components of well being, and includes how the strength of the relationship can impact the potential for reconciliation between ecosystems and regions (MA, 2005) (Figure 1).

Figure 1: Linkages between Ecosystem Services and Human Well-being (MA, 2005)

The framework for the MA considers human well-being as the main point of assessment, while acknowledging that biodiversity and ecosystems have inherent value of their own (MA, 2005). To assess the interactions between humans and ecosystems requires an

interdisciplinary approach considering that decision-making is also interdisciplinary, and that in different regions different policies are more applicable than others (MA, 2005).

2.4 Ecosystem Services

An ecosystem is a complex and dynamic system comprised of animals, plants, and microorganisms (UNEP, 2009). The components of an ecosystem interact with each other in varying levels across the system; there are usually stronger interactions between the core components, and weaker interactions at the boundary of the system (UNEP, 2009; TEEB, 2013). The boundaries of an ecosystem also link to the services that humans can obtain from the ecosystem. The MA states "humans are an integral part of ecosystems" (MA, 2005). There are four ecosystem services: provisioning, regulating, cultural and supporting (UNEP, 2009; TEEB, 2013).

The MA identifies 11 ecosystem services that are derived from 10 systems. The 10 systems are as follows: marine fisheries; coastal; inland water; forest and woodland; dryland; island; mountain; polar; cultivated; and urban. The 11 ecosystem services assessed by the MA from these 10 systems are as follows: fresh water; food; timber, fuel, and fiber; new products and industries from biodiversity, biodiversity regulation of ecosystem services; nutrient cycling; climate and air quality; human health: ecosystem regulation of infectious diseases; waste processing and detoxification; regulation of natural hazards: floods and fires; cultural and amenity services (MA, 2005). For all ecosystem services, biological diversity is necessary to maintain supply for humans. However, human interaction with ecosystems has caused biological diversity to decline, with all services being impacted (MA. 2005).

Humans generally consider the condition of ecosystems based on the how much they can relate and rely on the service they stand to gain from the ecosystem being considered (Carpenter et al., 2009). Over the last two centuries, many methods have been established to access and also assess the ability of the ecosystem to consistently provide a service that can improve well-being (Carpenter et al., 2006; MA, 2005). However, access and distribution of these services is not evenly spread over different regions, and the extreme gap between the rich and poor within one nation, but also globally is an example of the inequality of accessibility to ecosystem services (MA, 2005). To better distribute services, stakeholders must consider which services are most important to their populations, and how they can be integrated for maximum human well-being benefit (Carpenter et al., 2009). Ecosystem services can be evaluated by assessing the stocks, flows, and resilience of the service.

Maintaining the service can be aided by adding economic valuation to the service, which can help communities, levels of government, industrial and corporate developers to understand the value of the intrinsic capital in the system (TEEB, 2009; MA, 2005). This can be assisted by also considering indirect drivers such as demographics, socio-political and economic, and cultural factors, rather than just direct drivers such as invasive species or landscape change (Carpenter et al., 2006; MA, 2005). This would help to add a valuation factor to services that can and do have strong impacts, like climate change, so that they can be effectively marketed to increase discourse, influence policy making and strategies for service protection, and have more social value overall (Carpenter et al., 2009).

2.5 Watersheds

The United States Geological Survey (USGS) defines watersheds as, "the area of land where all of the water that falls in it and drains off of it goes to a common outlet" (USGS, 2016). Watersheds are integral part of the ecosystem, as they are a primary source of drinking water; have many industrial uses (agriculture/manufacturing); and are a part of the visual landscape with uses for recreation and leisure (Conservation Ontario, 2013; US EPA, 2012). Watersheds vary in size, but all are basins that lead to a common outlet such as a reservoir, to the mouth of a bay of water, streams or rivers (USGS, 2016). Watersheds include all the ground water, but also the surface water, which can consist of bodies of water (small and large), as well as wetlands (USGS, 2016). The physical location of the outflow point determines how the watersheds drain, and it can be that the larger watershed can have many smaller watersheds within it (USGS, 2016). Watersheds and water-resources are renewable due to the water cycle, which includes: precipitation, condensation and evaporation. Additionally, infiltration of water in to the soil, water storage and water usage determine how the water will move through the ground. Not all precipitation that occurs in a watershed will flow out, as there are many factors that determine how the water can flow (USGS, 2016). Watersheds are broadly categorized under inland water by the MA, with the central concept of being used as permanent bodies of water situated inland from the coastal boundaries (MA, 2005).

2.5.1 Watershed Management and Governance

Maintaining the quantity and quality of a watershed is necessary, especially in light of the changing surrounding environment influenced by actors such as rapid and intense urbanization, climate change, invasive species and vector-borne diseases, and changing demographics and population needs (MA, 2005; US EPA, 2012). All water sources will

eventually make their way to the watershed. Therefore, it is important to protect and maintain the watershed through effective management strategies.

The integrated watershed management approach seeks to represent multiple stakeholders (local communities, industry, development) who can formulate management strategies that cover the watershed entirely, and can deal with the complexities of the scale and uncertainties of the environment (Veale, 2010). This approach has more political implications. The integrated watershed governance approach aims for multiple objectives to be studied and addressed as a complex system, as well as improve outcomes of health, sustainability and socio-ecological resistance (Parkes et al., 2010). This approach is more of a social process, and seeks to "integrate social and environmental concerns with the determinants of health and well- being" (Parkes et al., 2010).

Watershed management includes studying the watershed and it's related entities, and ensuring that water quality is sustained at a level that is needed for human drinking water, as well as animal and plant ecosystems. Watershed governance includes using a collaborative effort between management authorities and citizens for the purpose of conducting research about the watershed, and also to find more interdisciplinary solutions to water issues (Canadian Council of Ministers of the Environment, 2016) . Both governance and management have overlapping characteristics such as studying the watershed, finding the local issues, developing strategies to address these issues, implementing the solutions and then monitoring the results. The entire process has stakeholder input at each level, and supports collaboration to meet community needs and interests. Governance and management of watershed are important for maintain

ecosystem health (Veale, 2010; Parkes et al., 2010).. The prism governance framework as described by Parkes et al. (2010), gives four perspectives on ecohealth and watershed governance: "Perspective A: governance for sustainable development (watersheds, ecosystems, social systems); Perspective B: governance for ecosystems and well-being(watersheds, ecosystems, health/well-being); Perspective C: governance for social determinants of health (watersheds, social systems, health/well-being); and Perspective D: governance for social–ecological health promotion(ecosystems, social systems, health/well-being)." This approach is useful because it seeks to integrate these perspectives to be able to find new ways of thinking about governance across different boundaries, and ultimately improve watershed governance (Parkes et al., 2010).

2.6 Indicators

Indicators are generally described as being the "interface between science and policy", as a way to measure quantitatively (by observation and assessment) the value, or progress, or specific characteristic of a programme, intervention, or framework (Heink & Kowarik, 2009). The indicator can be used to evaluate an intervention to see if it is on target to meet its objectives. Indicators can be descriptive, and address the state of the system or can analyze changes. Indicators can also be normative, where they are used to specify future conditions, or test whether an outcome was ultimately achieved or not. Normative indicators include: prescriptive indicators and evaluative indicators, which are often used together to determine progress and success of interventions or programmes. Indicators that can be used as both components and measures are referred to as hybrid indicators, and as long as the researcher can clearly define how they are both descriptive and normative. In this case, context is important to understand. Indicator terms can be

narrowly or broadly defined, but it is recommended to define it in broad context, and distinguish indicators based on their inherent attributes (descriptive or normative) (Heink & Kowarik, 2009).

Summary

This chapter describes the ecohealth approach, the millennium ecosystem assessment and ecosystem services, all of which can shed light on human health and well-being in terms of use and management/governance of watersheds, and indicators for assessment.

3. Methods

This chapter outlines how the data was collected for my research project. It specifically outlines the method of qualitative analysis, including semi-structured interviews and content analysis. The chapter also describes the research process, which included participant recruitment and selection, informed consent

3.1 Overview

This research project builds on a previous project, and was formed in conjunction with the Credit Valley Conservation, after holding a workshop in which internal and external groups of experts convened to discuss and develop a list of well-being indicators that relate to watershed management and governance. Twelve indicators were developed: air quality, traffic patterns/modes of transportation, land cover change, urban heat islands, % imperviousness, % canopy cover, water quality index, % people using natural space, proximity to green space, connectivity of green space, access to green spaces, and wildlife (habitat).

These twelve indicators were assessed using different categories including, but not limited to: the indicators inherent value as an ecosystem service, the well-being benefit gained through the indicator, and the potential uses for the indicator by managers/governance stakeholders.

The previous researcher identified some of the interviewees as being city/regional staff members, conservation specialists, or from public health and health organizations. The types of questions asked in the interviews were related to the indicators, and were structured to be open-ended. Questions were related to the strategic mandates or

applications that may be related to each indicator, or what the interviewee thought were the benefits of each indicator to health and well-being, and how indicators can be employed for well-being. There are six questions total, with time for a short introduction and an informed consent. The previous researcher then conducted a qualitative content analysis by transcribing the audio from interviews conducted, and reviewed the information garnered by selecting categories from the questionnaire and then looked for key points mentioned, and the opinions (similar or differing) of the interviewees.

3.2 Consent and Ethics

This project involved human participants, and as such required an informed consent from each interviewee prior to their interview. The York University Human Participants Review Sub-Committee, and my supervisor approved the informed consent form that was created by the previous researcher. It was modified slightly to add my name into the contacts section. The consent form included details of how the information will be recorded, used and stored.

Each participant returned the Informed Consent form, either by printing, signing and scanning it back to me; by faxing their signed form to FES; or by writing within the body of the email that they confirm that they have read the informed consent form and agree to the conditions.

Prior to starting each interview, I confirmed with each interviewee that I had received their Informed Consent form, or they would send it to me immediately afterwards. I also reiterated the fact that I would be recording the interview.

Grounded theory is a popular method that focuses on generating a new theory from data collected, instead of the more traditional method of testing an existing theory by collecting data (Birks and Mills, 2011). This theory was formed by two sociologists,

Glaser and Strauss in 1967, and is based on their work studying dying in hospitals (Walker & Myrick, 2006). Grounded theory focuses on using data gathered in the field to create, define and use novel concepts (Corbin, 2017).

3.3 Grounded Theory

Some of the features of grounded theory that make it unique in qualitative research and analysis is that the concepts are chosen and created during or after the data has been collected, and not prior to data collection (Corbin, 2017). Additionally, the researcher does not try and make the data fit into a theoretical framework (essentially defeating the purpose of grounded theory), and the data collection and analysis are co-dependent as after initial data collection the researcher will analyze the data to be able to continue data collection (Corbin, 2017). In this way, the methods, methodology and philosophy of the research design are interconnected, leading to more comprehensive findings (Birks and Mills, 2011). Concepts are key to grounded theory, as concepts are developed the analysis will develop to produce a resulting theory (Corbin, 2017). The advantage of grounded theory is that because methods are not initially set, the overall design of the study can be adapted as necessary as the researcher progresses through the study (Corbin, 2017).

The steps in grounded theory are as follows. A brief literature review can be conducted to reduce misconceptions before beginning the data collection process. Then, data collection can be done through a variety of means, but generally includes observation, interviews, document review, videos, letters or memoirs, or an additional source that may be useful for the researcher (Corbin, 2017). Then the analysis of data can begin. Data analysis in grounded theory is a process that includes basic description of data, leading to conceptual organization, and then theory development (Patton, 2002). Data is analyzed through the

coding process, where the researcher thoroughly examines the data to form a theory (Walker & Myrick, 2006). Memos and diagrams can also be created so that the researcher can record their thoughts to develop their theory. The process is concluded by producing a write-up of the themes the researcher has developed (Corbin & Strauss, 2014). Because there are many points of comparison of concepts during the process, grounded theory is self-checking and therefore is able to eliminate self-bias to produce a theory that is insightful and able to applied to the problem at hand (Corbin, 2017).

3.4 Participant Selection

This project is continuation of a previous project, of which the methods are summarized above. Therefore, participant selection was done with the intent of increasing the size of the group to be able to conduct further analysis. The previous researcher was able to do 19 interviews. The target was to conduct 21 interviews. I aimed to select participants in environmental and conservation, health, and policy fields. I was hoping to be able to conduct 21 interviews to bring the total to 40 participants. I was able to conduct 19 interviews, of which 15 interviews have audio recordings. This is because four interview's audio recording failed. One interview did not have a recording or written notes, so I did not include it in the list, which brings the total number of interviews to 18. Of these, two recordings failed to save, and one recording did not occur (did not engage in the call). These audio failures were a limitation, and will be discussed in the limitations section of this paper in more detail. A further three interviews were scheduled, but two participants declined afterwards due to lack of availability, and one did not return attempts for a follow up to fix a date and time. The breakdown of participants is as follows:

Group Type	Round 1 (Previous Researcher)	Round 2	**Total**
Government (Municipal, Provincial)	4	2	**6**
Conservation/Environmental	7	10	**17**
Health	5	4	**9**
Education	3	2	**5**
Total	**19**	**18**	**37**

Table 1 Interviewee sorting into group type

In total, I contacted 100 potential participants. I identified participants through a combination of a list of potential contacts from my supervisor, the participants that declined the previous researcher, by searching online for potential participants in municipal offices and conservations/environmental organizations, and by recommendation of other interviewees (snowball sampling). For all the participants I identified myself, I would look at their organization and select a few people to email and call from each organization (that would be most relevant). I first emailed participants with the informed consent form, and details about the purpose of the project. If the potential participant asked for further information, or agreed to participate I fixed a date and time with them. If the participant did not reply, after three days I called them to see if they would be willing to participate. Many participants who declined felt that they lacked the expertise to answer the questions. This limitation will be discussed later in this paper.

3.5 Process Overview

The research was conducted in two stages, interviews and content analysis. For stage one, the interviews, the candidates are ideally conservation specialists, municipal/regional

environmental planners, public health officials, environmental activists and educators. Stage one provided the data that was analyzed in stage two. In stage two, a content analysis was conducted using NVIVO software to find key words, and observe how they were used during interviews to be able to develop general themes. A final report was developed to report on the findings.

3.5 Qualitative Analysis

In human subjects, qualitative research can be done in three ways: in-depth interviews with open-ended questions, observations, or written documents (Patton, 2011). Interviews are particularly useful in qualitative research as they are able to garner direct quotes from interviewees, as well gain insight into their personal opinions and knowledge about the topic (Patton, 2011). Alongside of interviews, document analysis and general observations can also be made. Observations include studying people's activities with extreme attention to detail. It can include looking at actions or behaviour, and social interactions. Document analysis includes looking for written records that can include personal diaries, survey questionnaire responses, official publications, reports, correspondence; and then studying the passages to find quotes, or excerpts that are useful (Patton, 2011).

Of the six interview questions, five were open-ended and one was fixed. This is an example of how qualitative and quantitative data can be combined at a very basic level, and can lead way to a better content analysis. Qualitative research is also useful because it allows for names of people or organizations to put to the face of the data collected, which can help with understanding the contents of the data in reference to the original research question (Patton, 2011). In this particular project, a qualitative analysis is best

as it allowed for use of open-ended interview questions, which allowed the interviewee to give their opinions on the 12 indicators in the context of their organization or position.

3.5.1 Stage 1 - Semi Structured Interviews

A semi-structured interview is a useful method in qualitative data collection. Semi-structured interviews have room for flexibility when asking questions to the interviewee, and modifying the questions based on the participant's response (Whiting, 2008). Since the participants will be of various disciplines, it is appropriate to use semi-structured interviews so that various ideas brought up during the conversation can be used to steer the interview as best as possible.

Semi-structured interviews are normally conducted in six stages: "selecting the type of interview, establishing ethical guidelines, crafting the interview protocol, conducting and recording the interview, analyzing and summarizing the interview, and reporting the findings" (Rabionet, 2011). In this case, the method was pre-selected, and I was only responsible for conducting and recording the interview, and reporting the findings. Semi-structured interviews offer a chance to be able to cover the topics within the interview questionnaire, but also any other topics that might come up during the conversation. Because they are less rigid than formal interviews, the interviewee is able to relate their answers in a more story-based format, and the interviewer is also able to probe the interviewee further if necessary (Rabionet, 2011;Whiting, 2008). Additionally, since participants are knowledgeable about their fields, they are able to reflect on their responses and add experiential details about the topic (Whiting, 2008).

3.5.2 Structure of Interviews

All interviews were conducted on the phone. Before the interview, I would prepare by finding details (if available, or applicable) about the organization that the individual

represented. Participants had a time and date set in advance of the interview, and the questionnaire was made available to them. They were advised to return the Informed Consent form as soon as possible.

During each interview, I stated the purpose of the interview, the approximate timeline or length of the interview, and reiterated that I would be recording the interview and that the information would be kept confidential, and that if necessary they are allowed to decline to answer any question. The interviews were recorded using the "Call Recorder" application available from the Google Play Store on my android device. To try and get good audio quality, I used a microphone when conducting the interview, and sat in a quiet room. This especially reduced background noise on my end. When the call ended, the application gave an option to save the audio. This was stored on my device, and then moved to Google Drive. I then accessed the audio from Google Drive, converted the audio file from ".amr" format to ".mp3" format to be compatible with the audio conversion website. These .mp3 files were then uploaded to an online audio conversion website (www.voicebase.com), where the audio was converted to text. This website did a preliminary version of converting the audio to text. I then listened to each audio file and went over the preliminary transcript to correct it and ensure it matched the audio.

To conclude the interview questions, I asked the same follow-up question to all interviews, which was: if they had any general comments or questions, and would they add or remove any of the indicators mentioned (if they felt that any were missing, or if they were not relevant).

3.5.3 Stage 2 - Content Analysis

The second stage of analysis was a content analysis. A content analysis is a form of text or document analysis, which seeks to reveal patterns, and themes in a systematic way

(Hseih & Shannon, 2005). The text can be systematically evaluated and then coded by the researcher by creating categories, which can then produce general observations about the data, including common phrases or sequences of words (Krippendorff, 2004). This can be done manually or with the assistance of software. While this is an overall qualitative method of analysis, as it is possible to find word meanings within the context of how they were said, it also has a quantitative aspect as the number of times a word is repeated or used in a sentence can also be found (Krippendorff, 2004; Hseih & Shannon, 2005; Neuendorf, 2017).

Content analysis is useful because a large volume of data can be examined to find and interpret messages that have been communicated (Neuendorf, 2017). It is also a fairly inexpensive method of analysis, and software is easily accessible. A content analysis will hopefully reveal intentions or different foci of the participants and the groups that they represent. There are two types of content analysis, conceptual and relational. The conceptual analysis is step towards relational, and normally includes identifying concepts found within the data or text, or reoccurring words that relate to a concept or theme in the data. Relational analysis is similar to conceptual that it is looking for reoccurring themes, however the purpose is to make a connection between the theme and other themes. Both would require coding of the data. For this project, the best type would be relational analysis, as other words and phrases appearing together with certain keywords can also be identified, and this can be a useful grouping to find other emergent patterns and concepts (Neuendorf, 2017).

For my content analysis, I first transcribed the interviews, which gave me a general idea of words and themes mentioned in the interviews. I then used NVivo software to help me

find themes within the data. The purpose of the content analysis is to reveal important concepts and themes in terms of watershed management and finding co-benefits related to governance and maintaining a healthy environment. The next section discusses the use of NVivo in qualitative research.

3.5.4 NVivo

NVivo by Qualitative Solutions and Research (QSR) Pty.Ltd of Melbourne, Australia, is software that is used for qualitative research, and can assist the researcher in organizing, analyzing and managing data (QSR Pty Ltd., 2016). NVivo can be used to find insights from interviews with open-ended questions through tools that aim to increase efficiency in data review (QSR Pty Ltd., 2016).

NVivo has a number of features that enable the user to store, view and manipulate data in different forms (Denardo & Levers, 2002). The software is able to link ideas in many ways, and can connect parts of a project that were previously unlinked through coding, creating of nodes within the coded areas, and displaying data in word frequency maps and tree displays. In any project, the data can be managed through documents, nodes and attributes (Richards, 1999). A node is first created, this is where a theme or point of interest is created. Multiple nodes can be created. Within the node, a sub- or child-node can be created, this gives an area to store information related to different topics of the overall node. Then the data is coded, and sorted into the child-nodes. Attributes can be applied to the data during the coding process, and this can be useful to find finite details from the data set, such as age or occupation. Then, by giving value to the attributes, assigning codes within the documents and nodes, the data can be brought together to display models that can highlight themes or repeated patterns across the data set (Richards, 1999).

3.5.5. Use of NVivo

Data was imported into NVivo in two parts. Under a new project, firstly, the previous researchers interview Microsoft Word files were transferred. Second, the interviews that I conducted were imported, after being transcribed, also in Microsoft Word format. A word frequency search was conducted to produce a word frequency map. This gives an idea of how often specific words are being used throughout each interview, and which words may be more useful to focus on. The word frequency map also gives a good starting point for which keywords are extremely likely to appear in all interviews, and is therefore a good place to create a node. More than one node can be created in one area, and to make further insights into the data a memo can also be created. Once several codes have been placed, I can step back and see potential themes emerging across the data. This can be corroborated by the themes that were noted and discussed during the interviews.

This info-graphic from NVivo explains this process.

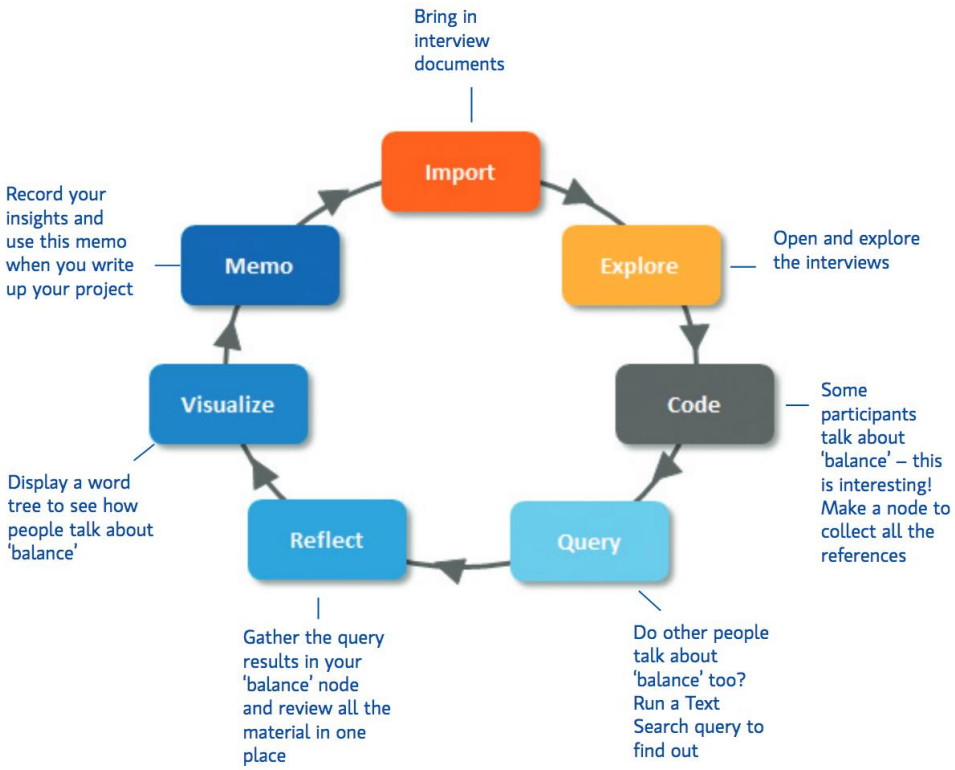

Figure 2: NVivo explanation infographic (NVivo, 2016).

The way I used NVivo is by first converting files into the same format. Then I imported the data into a new project. Then I created nodes for each of the twelve indicators. I then created child-nodes for each indicator, which included: benefits of each indicator, weaknesses of each indicator, which vulnerable groups they impact, and who can use this data. The child-nodes correspond to the questions. I then went through each interview and added codes where the indicators were mentioned. The query tool for useful in this as it can find where the words are mentioned in each interview. Each interview can be opened in a separate tab within the program, and the code can be added. Codes are easily identifiable through different colour schemes. After coding, it was much easier to

visualize what the interviewees had said as a whole, and overall themes could be identified.

4. Results and Discussion

In this section I will present and discuss the results of the NVivo analysis of the interviews that I conducted, with reference to the previous researcher's work. I will also present and discuss some figures that give quantitative value to question two of the interview.

4.1 Quantitative analysis of Question 2

The first question each interviewee was asked was to describe the strategic mandate of their organization. They were then asked to rank each of the 12 indicators on a scale of 1-5, in terms of relevancy to their organization. Figure 2 shows the responses of the 18 interviews I conducted. The box represents the interquartile range, and the horizontal (thick) bar represents the median.

Figure 3 shows that air quality and water quality index had the most relevancies to all participants. Urban heat island had the lowest relevancy to all participants. Wildlife had the largest variation in relevancy.

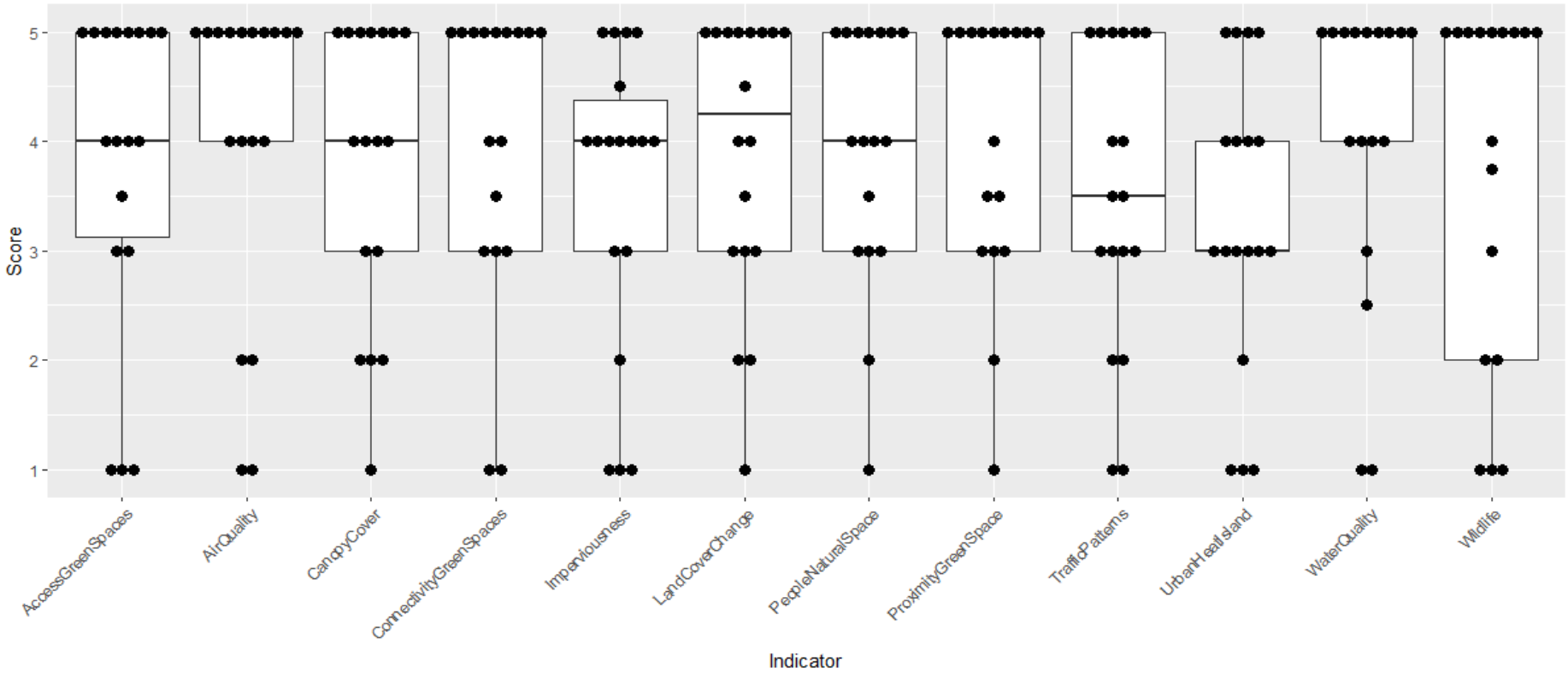

Figure 3: for Question 2, a Box Plot to show relevance of each indicator to the mandate of each interviewee's organization, where 1 is not relevant, and 5 is very relevant

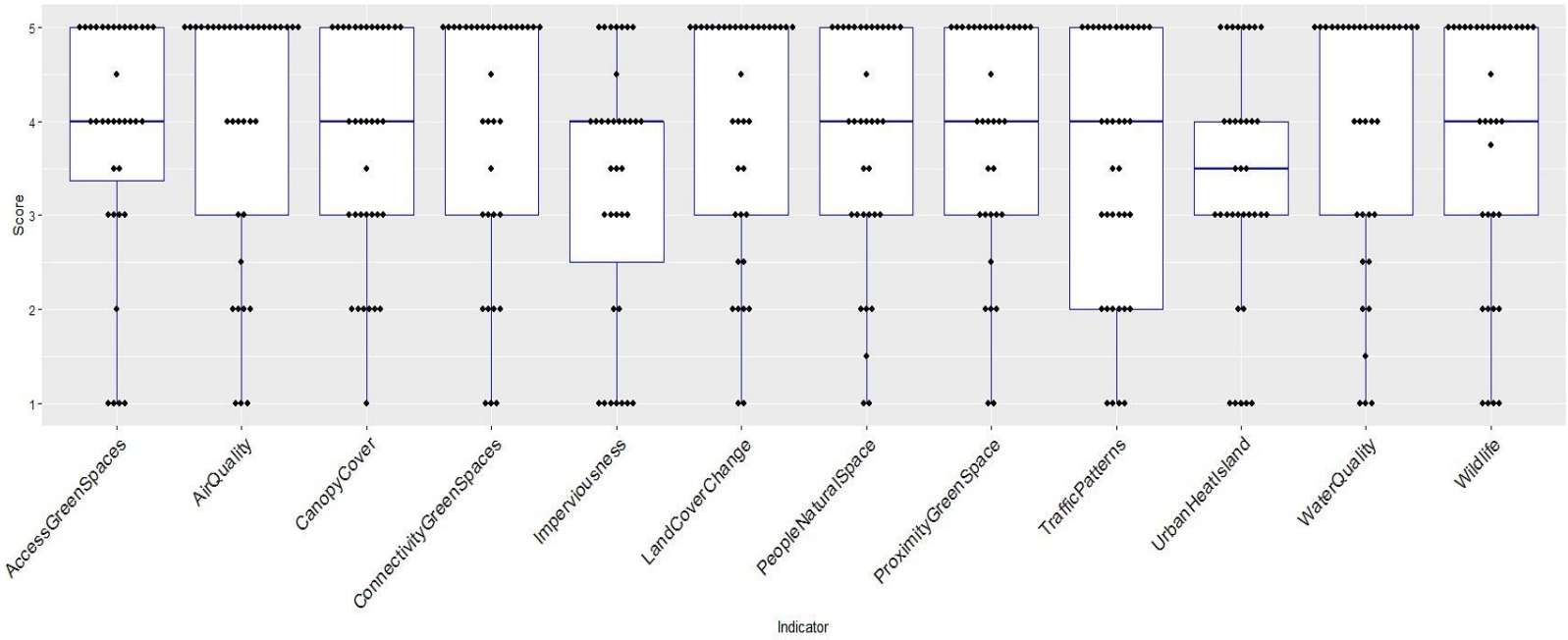

Figure 4 for Question 2. Box Plot to show relevance of each indicator to the mandate of each interviewee's organization, where 1 is not relevant, and 5 is very relevant, for a combined 37 interviewees.

Figure 4 contains the responses for both my interviews as well as the interviews of the previous researcher. In this box plot it can be seen that urban heat island is still the least relevant indicator to interviewees organizations. Traffic patterns and mode of transportation has the highest variability in terms of relevancy. The other indicators are mostly similar. For example, the indicators for people using natural space and proximity to green space have a nearly identical distribution. It can be seen that for nearly all the indicators the box is greater than 3, which means that 75% or more of the interviewees found these indicators at least somewhat relevant to their organizations.

To further analyze whether there are relationships between indicators, I looked at the correlation between all indicators.

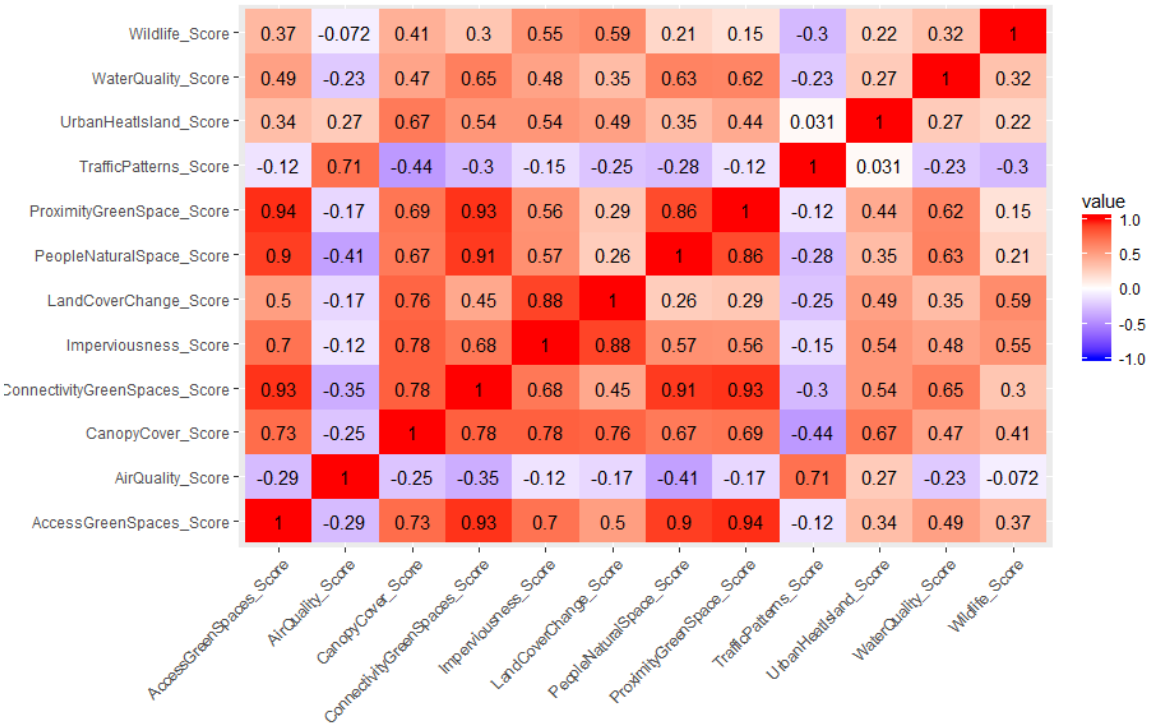

Figure 5: For Question 2. Heat Map showing the correlation between all indicators, using Pearson's correlation coefficient.

To look at the correlation between the indicators, the Pearson correlation coefficient was calculated. This coefficient represents the strength of the linear trend, if any, between a

pair of indicators. Positive values indicate a positive relationship, meaning that if one value is high, the other will be high as well. On the other hand, a negative value indicates that if one value is low, the other will be low as well. The absolute value of the coefficient indicates the strength of the relationship, where values above 0.7 are considered strong, and values near 0.5 are considered moderate, and below this are considered weak.

In figure 5 a strong relationship (i.e. greater than 0.9) can be seen between access, connectivity, proximity to green spaces, and % of people using natural spaces. This relationship is unsurprising, considering that if someone believes that access to green spaces is important, they would also think that proximity to green space is important, because proximity makes green space more accessible. They interviewees would also want people to use natural space if they care about accessibility. This trend is intuitive and figure 5 is quantitatively shows the existence of this trend.

There is also a strong relationship (e.g., greater than 0.7) between air quality and traffic patterns/modes of transportation. This is again intuitive, as traffic patterns/modes of transportation heavily influence air quality due to emissions and pollution. This correlation is strong, however it is not applicable to all respondents. Some respondents, such as city planners, were concerned with development that is connected by transit, but are not necessarily concerned about emissions, which can lead to poor air quality.

There were no substantial negative correlations, with the largest negative correlation being between traffic patterns/modes of transportation and % canopy cover. With the exception of air quality, most of the correlations between traffic patterns/modes of

transportation and other indicators have weak negative correlations. This also applies to air quality, where the exception is traffic patterns/modes of transportation, and the other indicators all have weak negative correlations.

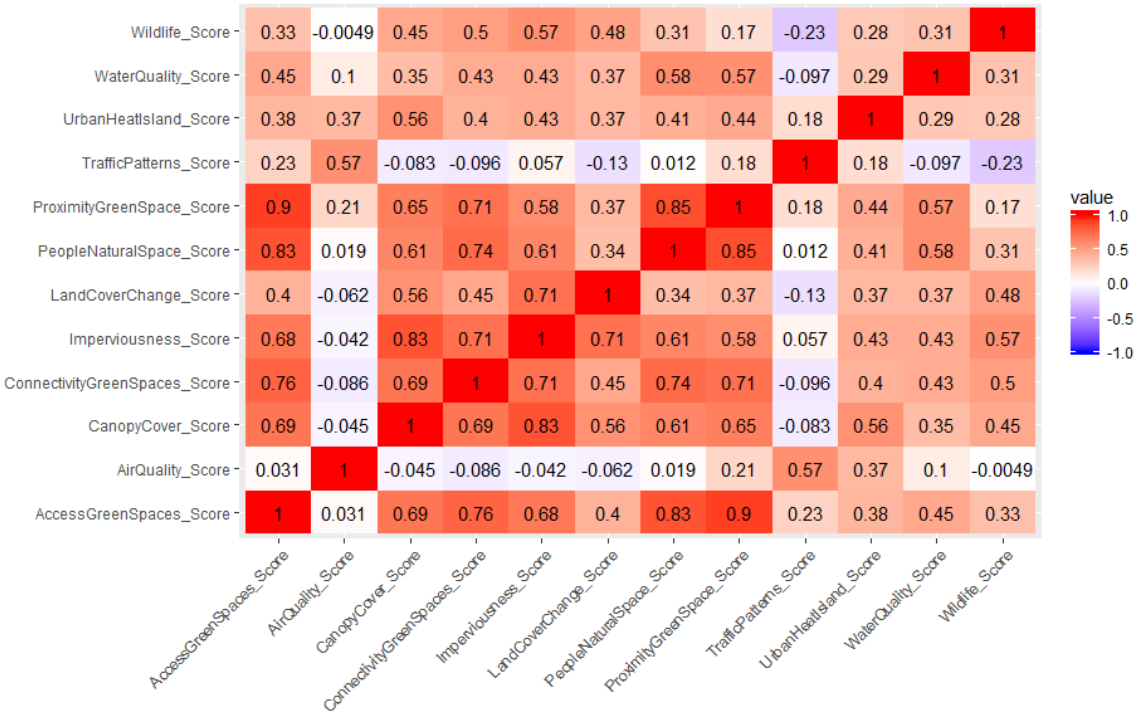

Figure 6 Heat Map showing the correlation between all indicators, using Pearson's correlation coefficient for combined 37 interviewees.

Figure 6 combines all interviewees from interviews I conducted, as well as from the previous researcher. Here we can again see that access and proximity to green space, and % people using natural space have a strong positive correlation (e.g., greater than 0.8), however, connectivity to green space is slightly lower (0.76). Another strong relationship (e.g., greater than 0.8) can be seen between %imperviousness and canopy cover. This relationship can be explained that if there is high % canopy cover, it more likely that the area is a natural space, which inherently decreases the %imperviousness. High canopy cover in cities is usually in areas such as parks, and the imperviousness is higher than on

concrete for example. Traffic patterns/modes of transportation and air quality are still linked, however the correlation is now weaker in comparison to the result from figure 3. Again, it can be seen that the respondents characterization of air quality is weakly related (e.g., below 0.5) to all other indicators except traffic patterns/modes of transportation, and vice versa.

Figure 7 shows the top 15 most used words in all of the 37 interviews. The next figures show the word frequency in a word cloud format.

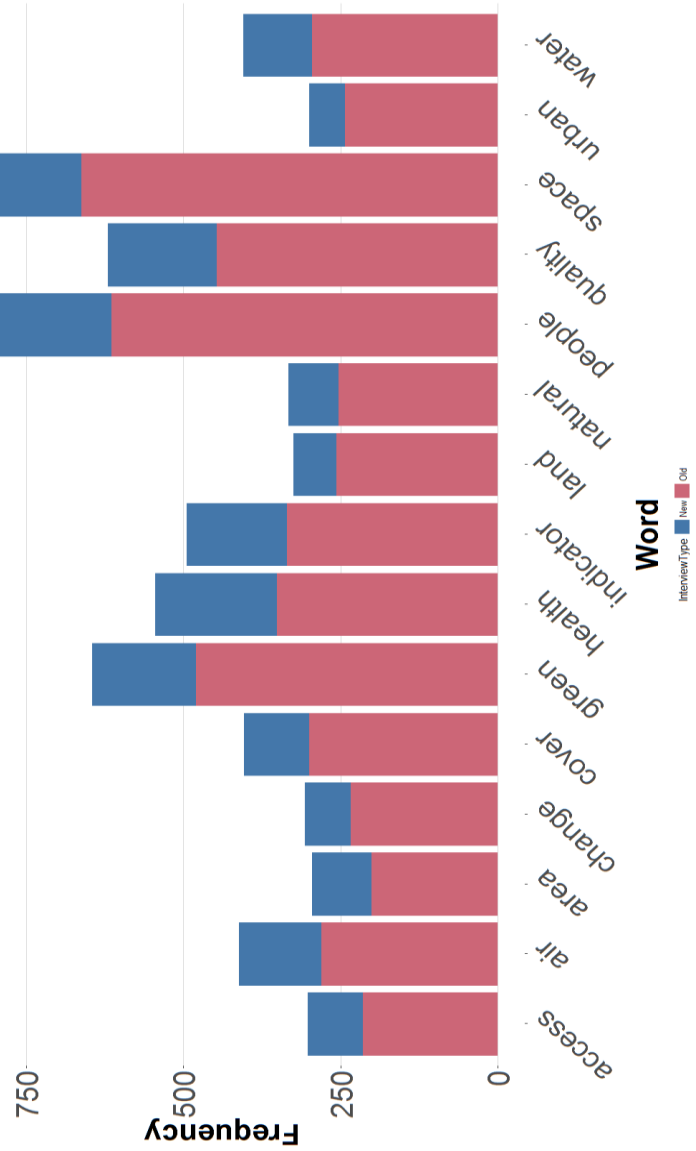

Figure 7: For Question 2. Bar chart showing word frequency in interview, representing the 15 most frequently used words. Red denotes the interviews from the previous researcher, and blue denotes the interviews I conducted. Blue (new) indicates the interviews I conducted, and red indicates the previous researchers interviews (old).

4.2 Overall picture of Interviews

To get an overall idea of the combined interview pool, I made word clouds that show the most frequently used words in all interviews. These are presented in figure 8.

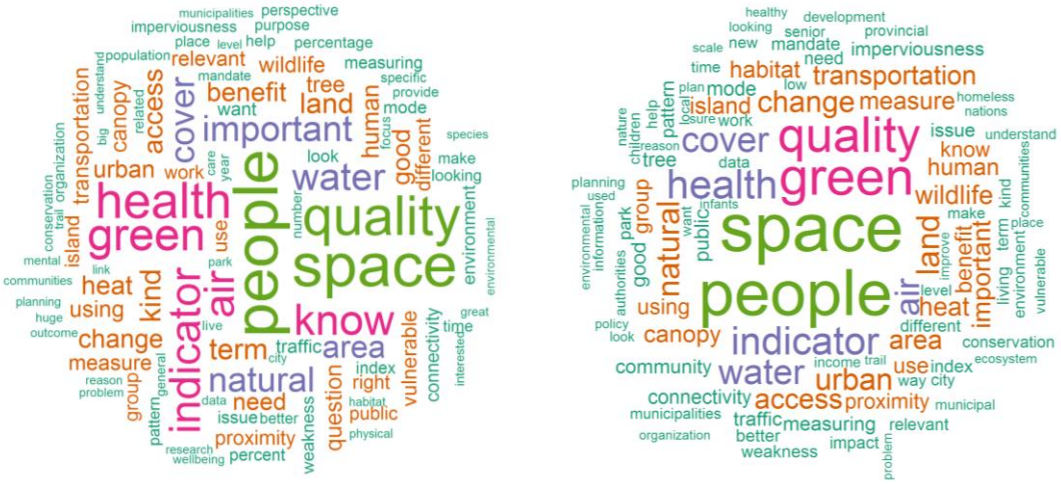

Figure 8. Referencing question 2: Word clouds showing the most frequently used words, where the size of each word represents how often they were used. On the left is the cloud for the interviews I conducted, and on the right is the cloud for the interviews of the previous researcher.

The word clouds show the frequency of word usage in the interviews, as seen in figure 8. Many of the same words overlap in both sets of interviews. I filtered the words, and removed words such as: “really”, “also”, “already”, “describe”, “after”, “for”, “example”, “maybe”, “sure”, “guess”, “obviously” and other filler words that are not specifically relevant to any subject matter. A number of words are expected to be repeated in both sets of interviews, as they are part of the interview questions. However, a number of words also appear in both sets of interviews as a result of the answers from interviewees. A few words of interest are highlighted in figure 8. Words that I was sure would appear were: “environment”, “health”, “indicator”, “people”, and “space”. Words that I was not expecting such a high frequency of usage were: “quality”, and “air”. Words that I expected to see a similar number of between the previous researcher and myself were: “space”, “people”, “indicator”, and “health”. Words that appear more than others are

significant because it helps me to understand their usage with reference to the question, and the types of words interviewees use when answering a question (considering that nearly all interviewees were established professionals in their field), and how it relates to their position at their organization.

4.3 Qualitative Analysis of Interview Questions 3-6

Each interviewee was asked to describe the benefits and weakness of each indicator, with the aim of improving human health and well-being. They were also asked which vulnerable groups are most at risk, and who can use the indicator and it's data. As a follow up question, they were asked if they had any suggestions for improvement of the indicators, or if they had an alternate indicator that may be more useful.

4.3.1 General features of all indicators

A general benefit of measuring an indicator is that it allows stakeholders to track the progress of an intervention or plan of action. It also allows changes to be made, for example if it can be seen that water quality is worsening over time, specific actions can be taken to figure out why the negative change has happened, and a positive changes can be implemented to improve the water quality. An interviewee said: "If you can't measure it, you probably can't control it, or perhaps it is more difficult to control it…if you can't measure it, you can't present the data in a quantifiable way that can perhaps be more persuasive to the public and regulators".

A general weakness of all indicators is that human health outcomes are multi-factoral and cannot be attributed to only one indicator impacting human health at one time. An interviewee said: "I think by showing real data that's carefully measured that highlights that exposures are not equal between all populations or individuals and showing not just the indicator….multiple exposures, multiple variables like age and baseline disease,

genetics, and when you look at a fairly complex set of risk factors together that you really see the most vulnerable because they have not just one, but multiple factors against them".

Additionally, some indicators are more difficult to measure than others, and are data for some may not always be recently collected. For example, it is difficult to measure the % of people using natural space, as there is a loose definition, but no universally agreed outcome of what the use is or should be, and to implement this indicator as measure of human health and well-being it would need a definition. Another example is that land cover change, and percent canopy cover are all long-term indicators, and require measurements over years to be able to be understandable. Wildlife can also be a long-term indicator, as species are measured over seasons and migration patterns, and through different corridors.

4.3.2 Air Quality

Most interviewees stated that air quality is very important to human health and well-being. Even without in-depth knowledge of how air quality is measured and used, the interviewees concluded that human health is impacted by poor air quality. It was mentioned that poor air quality can directly lead to cardiovascular issues and cancer.

Air quality is an important indicator for vulnerable groups, especially those with pre-existing conditions such as asthma, or immune-compromised people. In this case, the young, seniors, and low-income people are especially vulnerable. One interviewee said: "…there are equity issues and often people from the lower income communities, they have less access or less green space and therefore things like air quality can be lower. So

some vulnerable groups, their health will deteriorate more significantly if air quality is lower".

Weaknesses of air quality as indicator that were mentioned by some respondents include the fact that air quality monitors are fixed, however air flow changes daily. Therefore, the air quality recordings have some level of error and fluctuation. Additionally, air is not bound by geographical boundaries. An interviewee said: "…it doesn't respect any boundaries that air is flowing through. So that makes it really challenging - you can measure air quality obviously, but then linking it to what's driving the quality of the air can be very difficult". Without additional testing it can be hard to identify the source, or if the source is known to be outside the jurisdiction (e.g., across the border) there is not much that can be done to reduce emissions transfer.

Air quality measurement is most relevant to the Ministry of Environment and Climate Change, and Ministry of Natural Resources. However, this indicator measurement requires international cooperation, and therefore can be a costly measure to implement.

4.3.3 Traffic Patterns/Mode of Transportation

Most respondents stated that this indicator is linked to air quality. They mentioned that a benefit of measuring this indicator is to determine usage, and improve active transport such as walking, biking, and increasing public transport and carpool usage.

From a planning perspective, heavy traffic corridors generally are more congested and have more emissions. Therefore, when planning for vulnerable group accommodation, these areas can be avoided, but links to public and accessible transit can still be established. An interviewee said: "vulnerable sectors of the community need to have access to all of the services that they need access to so a big part of that is ensuring that

they're mobile and are able to move through the community and so that requires a really diverse range of transportation options". It is also useful for tracking levels of particulate matter in dense traffic areas, tracking what kind and how much particulate matter is being expelled in a certain area, and determining if there is a greater risk to human health and well-being in specific areas compared to others. Another interviewee said: "it's mapping vulnerable groups to where you are looking at your traffic", to determine where vulnerable groups may be more impacted. One other interviewee said: "Traffic patterns can be barriers to people, mode of transportation can present barriers. So if we're living in an urban setting with car culture, where people don't walk, for example, there can be green spaces right down the block that they never access".

A weakness of this indicator is that it is more of a surrogate measure of air quality. Most respondents do not necessarily link traffic patterns/modes of transportation to human health, as more often than not 'traffic' is linked to vehicular traffic.

The Ministry of Transport and municipalities can use data from this indicator to plan and improve connectivity of traffic corridors by identifying areas that are not being serviced, and to improve public transit options, which can be beneficial to human well-being by improving how many people access their place of work, and recreational activities that they may take part in (e.g., accessing green spaces).

4.3.4 Land Cover Change

The benefit of this indicator is that the more land cover change occurs, the easier it is to see how human health has changed. Additionally, it can be seen that where land cover change has improved by creating more green space, reverting developed areas to natural

spaces, building mixed-use areas instead of purely commercial or residential, human health will also most likely improve.

Vulnerable groups include those who live off the land, as they would have to adapt their way of life.

A weakness of this indicator is that tracking how the land is changing is a slow process. Although data is available from planning permits, it can take a lot of time to be able to see how the land was impacted by what has been changed, what type of change it was, and how quickly it was done. In some cases, the change can be linear, such as in development as it takes years to build but the process is hard to stop or reverse.

This indicator data can be used by advocacy groups that seek increased green space within cities. Municipalities and planners, as well as provincial and municipal policy makers can use the data to guide decisions related to development.

4.3.5 Urban Heat Island

A benefit of this indicator is that is useful for planners to avoid hot-spots for development. It is also beneficial to measure as if urban heat island can be reduced, then air conditioner usage can also decrease. An interviewee said: “under the canopy of a tree, it's certainly shown that cities that have more tree cover have less people with heat stroke and problems”.

Vulnerable groups include infants and young children, homeless, elderly, and low-income people. Low-income people often reside in smaller homes/apartments, and may not be able to afford air conditioning.

A weakness of this indicator is that this may not be a negative in terms of heat provision in the winter. This is particularly useful for homeless people who may seek out shelter in

warm areas. Additionally, tracking urban heat island for qualitative data is difficult to collect, and so it is hard to measure especially because it takes a long time. An interviewe esaid: “I don't think it's an index that really speaks to people. I'm not saying that they don't care about it or wouldn't be interested, I just don't think that these are behaviour changing indexes”.

Environment Canada is most likely to have the data, and public health units can use the data to identify at-risk areas in advance of hot temperatures to put in preventative measures such as cooling centres that have air conditioning, water and rest areas on heat alert days. Planners can also use the data to plan for climate change impacts in the future.

4.3.6 % Imperviousness

Benefit of this indicator is that it is useful for climate change and disaster management planning. With climate change, it is more likely for flash flood events to occur. Planning for %imperviousness of city roads, sewer systems and boundaries is useful to prevent major infrastructure damage.

Vulnerable groups include low-income people or those who live in flood-prone areas. If they were to be flooded, most would be unable to re-establish themselves due to financial and property loss.

A weakness of this indicator is that different ground surfaces have different permeability rates, and it is difficult to measure percentage imperviousness without knowing what the permeability rate is. Additionally, to change or improve imperviousness in various areas is difficult and expensive and most are unlikely to change. If there is new development in an area, an improved surface that increases imperviousness can potentially be put in instead of traditional materials (e.g., regular asphalt). One interviewee said: “That

treatments and the applications to make something more impervious than natural is expensive and sometimes in these areas they don't the budget to use that kind of technology in these areas". Also, it is not the easiest indicator to understand, and one interviewee said: "imperviousness, I think, probably doesn't speak to anybody at all partially because they probably don't understand the implications of that, and they don't have to deal with any real outcomes from it - most of us don't".

The Ministry of Environment and Climate Change, and conservation authorities can use this indicator to understand the quality and functioning of the ecosystem, and for planning for floods and prioritizing public works. They can also identify flood prone areas and take preventative measures such as fortifying river banks and informing citizens.

4.3.7 % Canopy Cover

A benefit of this indicator is that increased canopy cover can provide shade and has flood control benefits. Canopy cover also provides air filtration benefits, which can lead to improvements in respiratory health. An interviewee said: "There are studies which have shown that the increasing the amount of trees in an area does improve human health and there's quite a few studies for respiratory, for cardiovascular, for a skin, for emotional health, even things like aggressiveness and ADHD. So increasing canopy cover is going to help with a whole bunch of human health indices".

Vulnerable groups include homeless people, as they can have cover from the sun. If they are too exposed, they are more susceptible to UV rays and can lead to skin cancer. As it also improves air quality, those who are susceptible to poor air quality (infants, elderly, immuno-compromised) will also benefit.

A weakness of this indicator is that canopy cover is usually measured on a region wide scale, and does not mean that the canopy cover is evenly distributed over the entire area. It could be that there is a large section of land near a border of a jurisdiction with a large amount of canopy cover that boosts the % canopy cover of the area, such as what happens if there are national parks or conservation areas within the region. Additionally, the canopy cover of the tree can take years to reach full potential, so a lot of young trees can be planted but they do not have potential to provide cover. Also, not all trees planted are beneficial to the environment, as some are invasive species (Norway Maple), and others are susceptible to invasive species (Ash tree). Although they still provide canopy cover, they may not be the tree of choice to be planted in an area.

This indicator can be used by conservation authorities, municipalities, and provincial authorities to have a measure of canopy cover for shade, recreation and air filtration purposes. It can also help to define policies for tree planting over years.

4.3.8 Water Quality Index

A benefit of this indicator is that it is a visual indicator, if the water quality is poor due to littering and debris, it is noticeable to the average person who might try and contact clean-up authorities. Additionally water is a necessity of life, and therefore water quality index must be measured. It can also give information about water borne illnesses as well as invasive species or pathogens.

All groups are vulnerable to changes in water quality, however those with pre-existing conditions or those living off the land are more susceptible to changes in water quality.

A weakness of this indicator is that water quality is impacted by natural features such as storms or heavy rain, which cannot be controlled. It is also not the easiest measure to

understand, and it can be difficult to convey and communicate the results of the water quality index to the population, especially if the water looks ok.

The Ministry of Fisheries, municipalities, public health units, and conservation authorities, can all use this data to be able to track the health of water-species, and for human health through drinking water standards.

4.3.9 %People using Natural Spaces

Natural spaces have mental health benefits (psychological), physical health benefits (e.g., exercise), and social health benefits (as places to congregate and socialize). An interviewee said: "If green space provides better health to people for no cost then we should be we should really be paying attention to creating green space for all people".

Vulnerable groups for this indicator are low-income people. This is because natural spaces are usually free of charge, and this allows low-income people the same amount of access as wealthier people.

A weakness of this indicator is that it is difficult to define a natural space. They can include a well-maintained private backyard, or a public park, or conservation areas. It was also noted that it is difficult to define the indicator, percent of people using natural space, quantitatively, as it is unknown and also difficult to measure how often people are using natural space; what counts as usage; what people consider to be natural space; and how accessible the natural space is. One interviewee said: "On its own, it possibly lacks a little bit of insight in understanding the reasons people may or may not be able to access or use natural spaces - understanding the drivers behind it - but it's a useful indicator in a high level basis".

Conservation authorities, provincial park staff and developers, municipalities and NGOs can use this data for improving natural spaces and increasing natural spaces. Data can also be used for improved design and functionality of natural space, and how to improve user experience and draw new users.

4.3.10 Proximity to Green Space

The benefit of proximity to green space is that the visibility of the area is more likely to increase the indicator of access to green space, which makes people more likely to use green space. This is a human health benefit as increased green space usage is linked to psychological, physical and social well-being.

Vulnerable groups that can benefit from this indicator are low-income people, because if the green space is closer to them they are more likely to visit the space, otherwise they may not be able to afford to travel to a green space. An interviewee said:

> There's some interesting work that's been done on pregnancy and infant weights and so on, and again it's very suggestive that people who access green space and live near green space - because they can access it - have better outcomes in terms of pregnancies and so on so. We're looking again at two factors here. One being that pregnant women are people who certainly have more concerns in terms of their health - they're feeding for two, they're carrying a second human being and so on. Particularly for people with no money with low incomes. Rich people that are pregnant, can access all kinds of services and so on, they have transportation, they can go to these spaces wherever they are and so on. People with less money can't, and they tend to live in places with less green space. So just by that factor alone, their outcomes for birth weights and so on can be compromised.

A weakness of this indicator is that in high-density areas, such as condominiums or apartment buildings, the green space may be in proximity, but the area of green space is quite small with inadequate size for such a large population. This may deter people from going. Another weakness is that an area may be identified as a green space, but may not be a type of space that is accessible (e.g, protected land).

Conservation authorities, planners, municipalities can use this data to design developments, housing and public spaces that are in proximity to green space.

4.3.11 Connectivity of Green Spaces

A benefit of connectivity of green spaces to human health is that they can broaden the user experience for all users, and have a positive psychological, physical and social health impact, leading to improved well-being.

Vulnerable groups that stand to benefit from connectivity of green spaces are again low-income people, the young and elderly as it can improve their mobility, willingness to socialize outside and enjoy being outdoors.

A weakness of this indicator is that nearly all respondents answered this indicator in conjunction with the proximity and access to green spaces indicators, as they felt that they were all very similar and intrinsically linked. Additionally, perhaps not all green spaces should be connected. Also, it is broadly defined as two purposes of connectivity; wildlife and habitat, and a different connectivity for humans.

Municipalities and conservation authorities can use this data to improve green spaces by adding trails, benches and incentives for people to visit green spaces. Municipalities may be interested in improving connectivity to improve active transport within their area. Additionally, wildlife biologists could be interested in the data to track species through different areas.

4.3.12 Access to Green Spaces

A benefit to human health is that if the green space is more accessible, it is more likely to be used. This is similar to proximity and connectivity.

Vulnerable groups that stand to benefit are low-income people, the young and old, and people living off the land. Accessible spaces reduce travel time and cost to green spaces, and increase likeliness of use. One interviewee said: “We have a AODA legislation which governs us and says that percentages of our park land and park amenities must be accessible for people with disability but, over and above that, we want people to get into our parks via trails, via various different gateways, and different types of surfaces. So it's very important that they get to our green spaces”. Another interviewee said, in reference to access to green spaces being a good indicator: “it's also an indicator of whether or not the government of Ontario is taking seriously the accessibility mandate legislated under the AODA. If we don't have the things that are accessible, it demonstrates that the government is not taking seriously the fundamental human rights of persons with disability”.

A weakness of this indicator is that this is too similar to connectivity and proximity to green spaces, and therefore hard to define. Many respondents gave grouped answers as they felt that these indicators were too similar, and that they could be merged to be one indicator. Many interviewees noted that the indicators of proximity to green space, connectivity of green space, and access to green space were very similar. Many interviewees therefore answered the question for these indicators as an aggregate indicator, and not individually.

This data can be used by conservation authorities, parks and recreation within municipalities, as they can understand if there are gaps and how they can help reduce the gaps by influencing improvement to green space access, proximity and connectivity.

4.3.13 Wildlife

The benefit of wildlife is that more species diverse places have better human health outcomes. It also has a psychological benefit, as when we see wildlife we are more likely to interact with the environment and visit green spaces.

Vulnerable groups include those who live off the land, as the wildlife is their food supply and can be threatened by weather, climate change and development. They must also consider risk of bio-accumulation contamination.

A weakness of this indicator is that it is difficult to measure the species in an ecosystem. Therefore, wildlife authorities are more likely to track specific species rather than all species because it is too labour intensive and unlikely to be able to measure all species in an ecosystem. It is also difficult to place a numerical value to the number of each species in an area as wildlife constantly moves and cycles through migration patterns.

Biologists and conservation authorities can use this data to protect wildlife, and reduce biodiversity loss. It can also be used for education purposes.

5. Conclusion

In this paper I looked at 12 indicators that relate to human health and well-being. Although the structure of this study was mostly qualitative, a quantitative aspect was introduced to further illuminate the findings and underlying trends gained through the semi-structured interview with experts in various fields relating to environment and health.

After comparison of my interviews to the previous researcher's interviews, there were similar trends in the frequently used words, and the correlations between specific

indicators were also similar. Additionally, many of the same benefits and weaknesses were discovered in both interview sets.

The mixed-methods approach was useful to flesh out similarities between the interview sets. The use of qualitative analysis software helped to solidify the results and comparisons between the data sets. Creating codes within nodes and child-nodes allowed for systematic review of all the data after for any given indicator. This allowed results to be summarized and discussed easily, and can hopefully provide additional information on the linkages of these twelve indicators to human health and well-being.

5.1 Recommendations

Recommendations that I would make are mostly related to the indicators themselves, and include reviewing the selected indicators to identify which are most useful to the overall project. Indicators that interviewees felt were most useful included air quality, water quality, % canopy cover; as these all have quantitative values associated with them, which makes the information gathered from them easier for the average user to understand. Additionally, they all have different properties that can be measured within them. Indicators that interviewees felt were not as useful because they were too similar include % people using green spaces, proximity to green spaces, connectivity to green spaces, and access to green spaces. Many participants answered these as a collective as they felt they were very similar, and could be grouped into two indicators instead of four separate ones, which could be more useful to identify behaviour patterns, and usage types. Indicators that were identified to be difficult to understand were % imperviousness, and wildlife (habitat). Both of these required additional explanation to nearly all interviewees, and many did not have any comment about them.

In relation to the CVC, who's main priority is to maintain and manage the Credit River watershed, indicators that relate more to water quality could be added including: flow, flood warning, turbidity. A recommendation made by many interviewees was that access and visibility of green spaces within the vicinity of where a person lives can positively impact their mental health, and that by knowing a green space is in their area helps a person's well-being and can also promote increased physical and social activity. Related to this, interviewees recommended that municipalities improve how they create and manage green spaces, so that usage and access of green spaces can be increased in green spaces close to the watershed and also areas that are further away.

5.2 Limitations

The first limitation is, because this was a continuation of a project, for consistency reasons, the interview questions could not be changed. The phrasing of the questions could have been clearer, and some interviewees felt unprepared to answer the question because they did not understand what kind of response it was trying to elicit from them.

Secondly, participant recruitment was an issue for me. It could be the timing of year for when participants were contacted (close to summer holidays), as many participants were out of office. I followed up with participants who were out of office, and did not receive many replies. Also, a number of potential participants wrote that they did not feel qualified to answer the interview questions. I think this partially relates to the phrasing of the questions, but can also relate to the specific nature of the twelve chosen indicators.

A third limitation was the use of an audio recording application. As the first few interviews were held without any issues, I did not take notes alongside the interviews. However, one interview audio was lost as the .amr file was irretrievable from my device,

and the audio was corrupted. This interview was not included in the data analysis, and thereby limited the data pool. I then un-installed and re-installed the app, after which there were no additional issues exporting the files. For one interview however, the call recorder app did not engage when the call was started as it had been doing normally for all other calls. Unfortunately, this was noted close to the end of the interview. For this interview, I had to recall from memory what the participant had said, and immediately after filled in the interview questionnaire from memory. Therefore, this interview transcript was more incomplete than others. After this point, I started taking fairly detailed notes as the interviews went along, and added time stamps to points that I thought were of interest so I could review them when I transcribed the interview. Two additional interviews, despite being 'saved' did not export to Google Drive. If the call is not saved, it gets written over by the next call in temporary storage. For these two interviews however, there were detailed notes and I was able to fill in the small gaps from memory.

A fourth limitation is more general, and related to qualitative research and content analysis of interviews. A limitation of content analysis is that the data is interpreted by the researcher, which can make it hard to generalize the results. In this case, I found it hard to gather generalized themes that were consistently present throughout the majority of the interviews that I conducted (not from the previous researcher), and not in a select few to focus on. Content analysis is also highly dependent on the quality of the code, which means that the researcher needs to remain objective. Since the previous researcher already had a content analysis without software, I had to avoid making the data 'fit' into

the themes he established from his interviews, and focus on the interviews I conducted to find themes.

Lastly, A fifth limitation is that learning NVivo software was a learning curve, and it is hard to practice using the software until data is ready. I found that I spent a lot of time watching tutorials online, reading teaching materials, and partaking in online seminars to be able to learn how to use the software. However, the qualitative analysis capabilities are strong, and if the project were to be done again, I would be more capable of placing the code, creating nodes and developing the themes. Additionally, the software will produce results that include 'filler' conversational words, for example: 'yeah/yes/no', 'also', 'already', 'really', 'say', 'probably', 'can', 'get'. These words were manually removed, in addition to the software's own stop words removal. This can be time consuming.

5.3 To improve upon these limitations

To improve upon the first limitation, during each interview if the interviewee was confused about the wording, I provided an example of the indicator in regards to the question. To improve upon the second limitation, the pool of interviewees could be increased by attending additional networking opportunities like workshops, or town hall meetings. Some interviewees kindly suggested other contacts that they thought might be interested in participating. This was helpful, and these contacts were followed up on. To improve on the third limitation, I would try to purchase an audio recording software or external recorder. The quality of the free applications is good, however some applications have better audio quality and are able to convert audio to text immediately with precision. To improve upon the fourth limitation, I added in quantitative measurements for the results of question number two. Although results are still based on my interpretation of

themes as they emerged from the data for questions three-six, this was able to provide some direction. To improve upon the last limitation, and improve time spent using NVivo, I would try and attend an in-person course, or purchase online tutorial lessons. Furthermore, other qualitative analysis softwares could also be tested to compare to NVivo. Other software on the market include "Atlas.ti", "HyperRESEARCH", "MAXQDA", and "NUDIST", although NVivo remains the most recommended software to use. NVivo and Atlas.ti are comparable, with similar capabilities and analysis tools. Alternatively, basic quantitative analysis can also be done in Microsoft Excel, although it is much more time intensive and would require a lot of manual work.

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Appendices

Appendix 1: Email to Potential Interviewees

Hello,
My name is Tahira Malik, and I am a graduate student at York University's Faculty of Environmental Studies. I am conducting a project that is seeking out the expert opinion of professionals in the environmental health field, and would be grateful for your participation.

This project is an extension of a previous project conducted by another student, and is in collaboration with the Credit Valley Conservation Centre. For consistency, I will be using the same questions as the previous researcher, and I am hoping to add to the previous database of interviews with your assistance.

I would sincerely appreciate if you are willing to participate in my study. For your convenience, I have attached both the survey questions and consent form.

If you agree to the interview, please fill out the consent form and send it back to me, or fax it to Martin Bunch's office at: 416-736-5679. Or, please reply to this email in the affirmative using the text of the informed consent form.

The interview will take no longer than 30 minutes on the phone, and a time that suits your schedule can be arranged. Kindly let me know what your availability and preferred time is within the following dates: May 25 – June 8.

I have added some information about the study below. Please let me know if you have any additional questions!

Best,
Tahira Malik
416-471-9864

Purpose of the Research
This research is a part of the York University and CVC's larger project on "Human Health and Well-being in the Credit River Watershed" and also a part of a MES major project. The overall intent of our research is to identify and communicate the relationships between watershed ecosystem health and human health and well-being in the Credit River Watershed. Semi-structured interviews will be conducted with members of different organizations that can provide their expert opinion regarding indicators that were selected in a governance stakeholders' workshop held in November 2014.

Role of the Research Participants
Your expert opinion in this survey is important to the successful completion of the research. We request you to please answer our questions to the best of your knowledge. The survey will take about 30 minutes. Your participation in the survey is entirely voluntary. You have the right to withdraw your participation anytime or not to answer any questions during the survey. This will not affect your relationship with York University and CVC. Should you wish to withdraw during the survey, the information obtained thus far will be discarded.

Confidentiality
All the answers will be recorded through digital audio device with your permission. Names of the interviewee will be kept in strictest confidence. The information obtained from you will be used solely for the York University and CVC's project and my research purposes. It will not be shared with other parties without your prior written consent. Transcripts of interviews may be retained or used in further related research.

This research has been carefully reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and complies with the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, you may contact the Senior Manager and Policy Advisor for the Office of Research Ethics, 5thFloor, York Research Tower, York University, telephone 416-736-5914 or e-mail ore@yorku.ca.

Appendix 2: Informed Consent Form

INFORMED CONSENT FORM

If you have any questions about this research in general or your role in this study, please contact any of the following:

Contacts:

Dr. Martin Bunch Associate Dean (Research), Associate Professor Faculty of Environmental Studies, York University bunchmj@yorku.ca	Tatiana Koveshnikova Ecosystem Services Project Coordinator tkoveshnikova@creditvalleyca.ca
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The overall intent of our research is to explore the relationships between watershed ecosystem health and human health and well-being in the Credit River Watershed. Semi-structured interviews will be conducted with key informants from the municipality, the Region of Peel, the Ministry of Natural Resources etc. to flesh out the indicators selected in the government governance stakeholders' workshop held in November 2014.

Purpose of the research:

We request you to please answer our questions to the best of your knowledge. The survey will take about 30 minutes. If you don't want to answer any question, you may do so anytime during the survey. It will not have any impact on the research and your relationship with York University and CVC.

Role of the research participants:

All the answers will be recorded on the questionnaire. Should you agree, use of audio device can be made for recording the conversation for accuracy of information only. Name of the interviewee will be kept in strictest confidence. The information obtained from you will be used solely for research purposes and kept in York University' archives for academic purposes only. Recording will be deleted upon transcription of the information.

Confidentiality:

This research has been carefully reviewed and approved by the Human Participants Review Sub-Committee, York University's Ethics Review Board and complies with the standards of the Canadian Tri-Council Research Ethics guidelines. If you have any questions about this process, or about your rights as a participant in the study, you may contact the Senior Manager and Policy Advisor for the Office of Research Ethics, 5th Floor, York Research Tower, York University, telephone 416-736-5914 or e-mail ore@yorku.ca.

I _____, consent to participate in the survey conducted by Tahira

Malik (principal researcher) using a semi-structured questionnaire. I permit/don't permit to use audio device. By signing this form, I will not waive any of my legal rights.

Participant Signature _____
Date_____

Principal Researcher _____
Date_____

Appendix 3: Interview Questionnaire

INTERVIEW PLAN

Date/Interview No.: **Name of Interviewer: Tahira**

Name of Organization: **Name of Interviewee:**

Introduction of the Researcher:
Hello, my name is Tahira Malik. I am a student of Master in Environmental Studies at York University. I am a principal researcher on this project. My task is to administer interviews with key informants on the indicators identified through a government governance stakeholders' workshop held in November 2014. The purpose of the interview is to solicit your expert opinion on fleshing out each indicator.

Indicators:

Air Quality	Traffic Patterns/Mode of Transportation	Land Cover Change	Urban Heat Island
% Imperviousness	% Canopy Cover	Water Quality Index	% People using Natural Space
Proximity to Green Space	Connectivity of Green Spaces	Access to Green Spaces	Wildlife (habitat)

Questions

Q1. Can you tell me in your own words what is the strategic mandate of your organization?

Q2. With respect to measuring progress toward this mandate, how relevant are the following indicators on a scale of 1-5, where 1 is not relevant and 5 is very relevant. Please also state the reason for your response.

Indicator	**Relevance (1-5)**	**Why**
Air Quality		
Traffic Patterns/Mode of Transportation		
Land Cover Change		
Urban Heat Island		
% Imperviousness		
% Canopy Cover		
Water Quality Index		

% People using Natural Space		
Proximity to Green Space		
Connectivity of Green Spaces		
Access to Green Spaces		
Wildlife (habitat)		

Q3. Can you describe the benefits of measuring an indicator to human health and well-being?

Indicator	**General Benefits**
Air Quality	
Traffic Patterns/Mode of Transportation	
Land Cover Change	
Urban Heat Island	
% Imperviousness	
% Canopy Cover	
Water Quality Index	
% People using Natural Space	
Proximity to Green Space	
Connectivity of Green Spaces	

Access to Green Spaces	
Wildlife (habitat)	

Q4. Can you think of the specific benefits of measuring an indicator to vulnerable groups, such as infants/children, low income and homeless people, seniors, people living off the land, new immigrants, and first nations?

Indicator	**Benefits to Vulnerable Groups**
Air Quality	
Traffic Patterns/Mode of Transportation	
Land Cover Change	
Urban Heat Island	
% Imperviousness	
% Canopy Cover	
Water Quality Index	
% People using Natural Space	
Proximity to Green Space	
Connectivity of Green Spaces	
Access to Green Spaces	
Wildlife (habitat)	

Q5. How would you describe weaknesses of each indicator?

Indicator	**Links to Vulnerable Groups**

Air Quality	
Traffic Patterns/Mode of Transportation	
Land Cover Change	
Urban Heat Island	
% Imperviousness	
% Canopy Cover	
Water Quality Index	
% People using Natural Space	
Proximity to Green Space	
Connectivity of Green Spaces	
Access to Green Spaces	
Wildlife (habitat)	

Q6. How can each indicator be employed to improve human well-being?

Indicator	**Use for Human Well-being**	
	By Whom	**For what purpose**
Air Quality		
Traffic Patterns/Mode of Transportation		
Land Cover Change		
Urban Heat Island		
% Imperviousness		
% Canopy Cover		
Water Quality Index		

% People using Natural Space		
Proximity to Green Space		
Connectivity of Green Spaces		
Access to Green Spaces		
Wildlife (habitat)		